XIII. Y793605

Peridotite, 16 grams

"moderately weathered"

Figure XIII-1. *Photograph of Martian meteorite Y793605 contributed by Dr. H. Kojima, NIPR.*

Introduction

In a survey of diogenites in the Japanese Antarctic Meteorite Collection, Yanai (1995) reported a sample of "type D orthopyroxenite" with intermediate plagioclase composition (shocked maskelynite) and speculated that it might be from Mars. This sample (originally designated Y79-25) was collected from the Yamato Mountain site in 1979 (figure XIII-1).

Mikouchi and Miyamoto (1996b, 1997) found that Y793605 *"shows strong affinities to both ALHA77005 and LEW88516 in petrography and mineral chemistry" (although it was found on the other side of the continent !).* Ebihara *et al.* (1997) have shown convincingly that these samples are identical.

The sample was originally apparently covered >>50% with fusion crust (Kojima *et al.,* 1997).

Petrography

The mineralogical mode of Y793605 is roughly 60% pyroxene, 35% olivine, 5% maskelynite and a trace of opaque minerals (Kojima *et al.,* 1997, Ikeda, 1997). Yanai (1995) reported a poikilitic texture, consisting mostly of coarse-grain pyroxene, granular olivine and interstitial plagioclase (maskelynite). Mikouchi and Miyamoto (1996, 1997) and Ikeda (1997) reported two

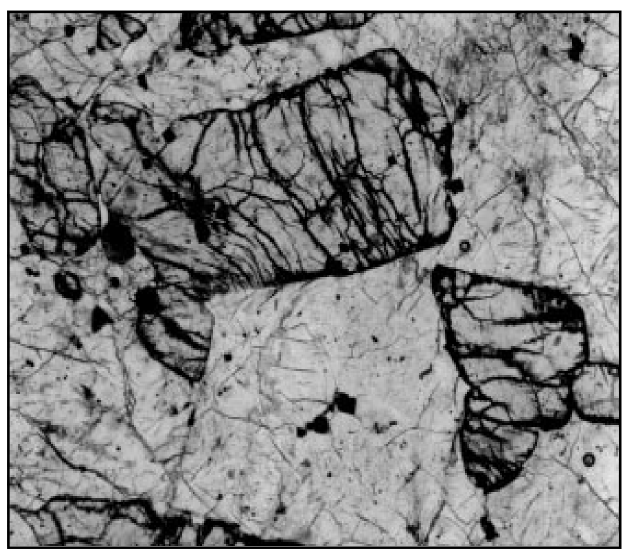

Figure XIII-2. *Photomicrograph of thin section of Y793605. Field of view is 2.2 mm. With permission of Dr. Kojima.*

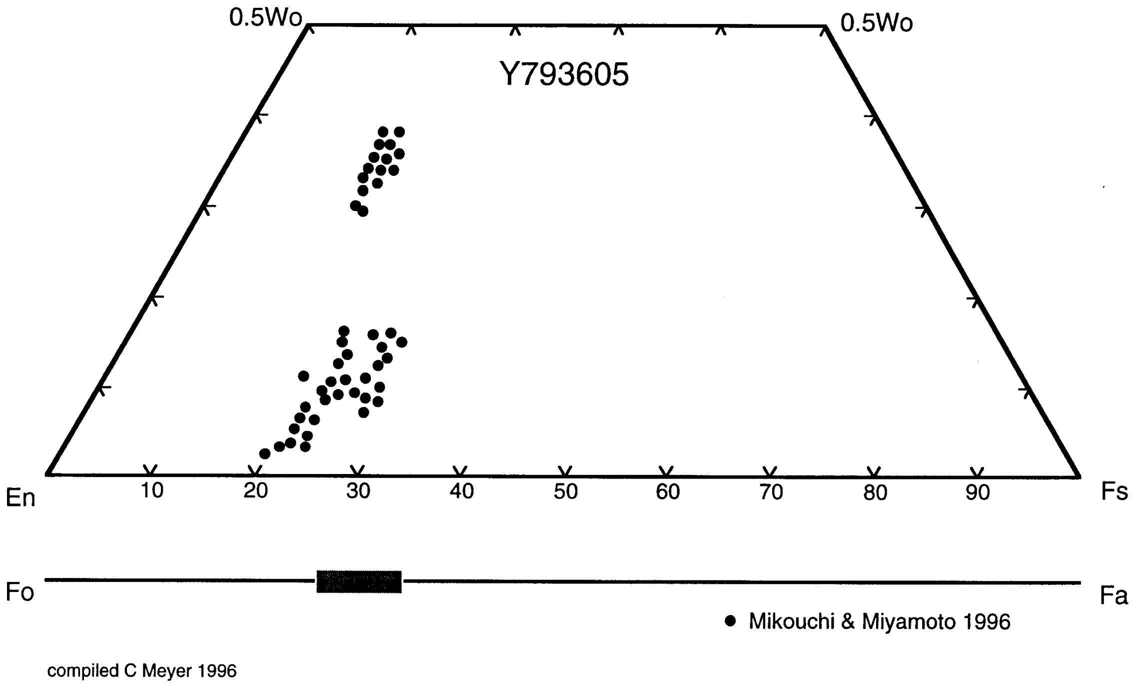

Figure XIII-3. *Composition diagram for pyroxene and olivine in Y793605. Data are from Mikouchi and Miyamoto (1996).*

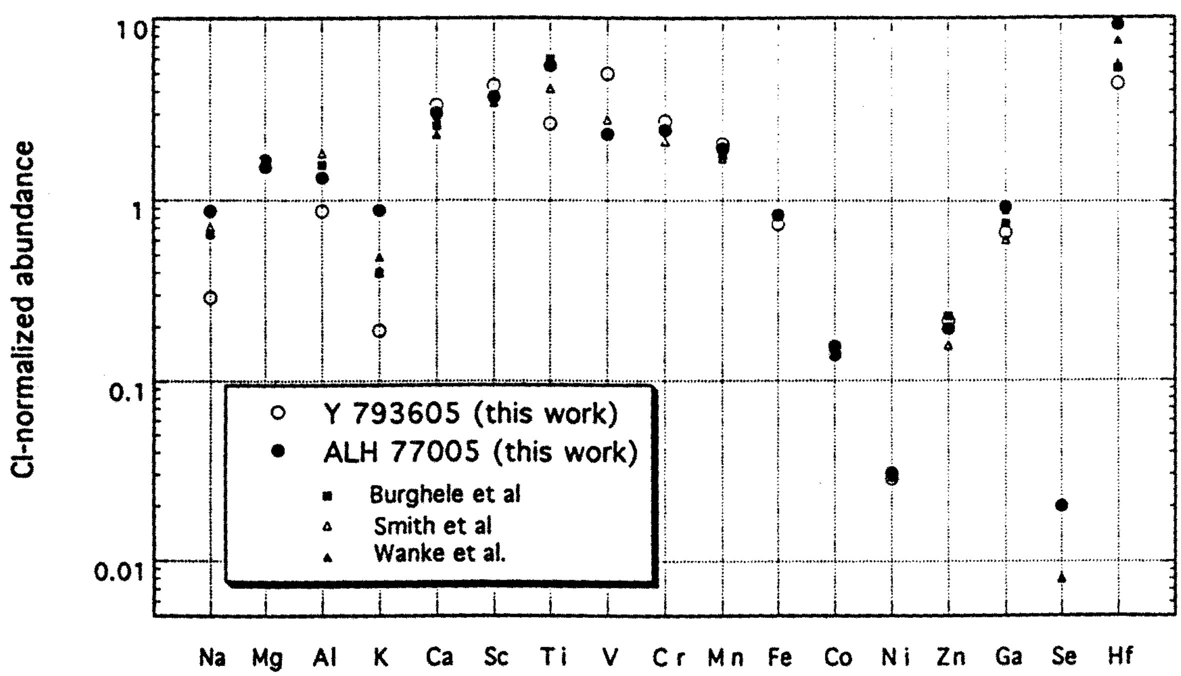

Figure XIII-4. *Chondrite-normalized abundances of major and minor elements in Y793605 determined by INAA and ICP-MS (Ebihara et al., 1997).*

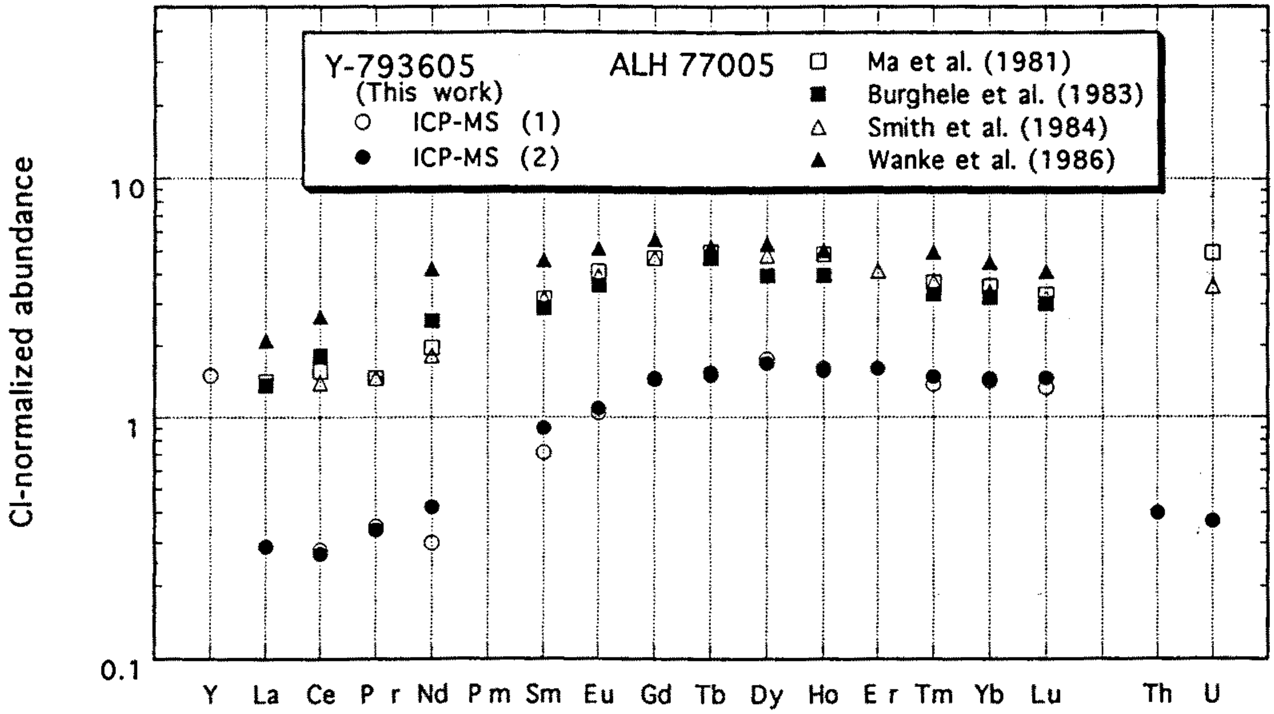

Figure XIII-5. *Chondrite-normalized abundances REE in Y793605 determined by ICP-MS (Ebihara et al., 1997).*

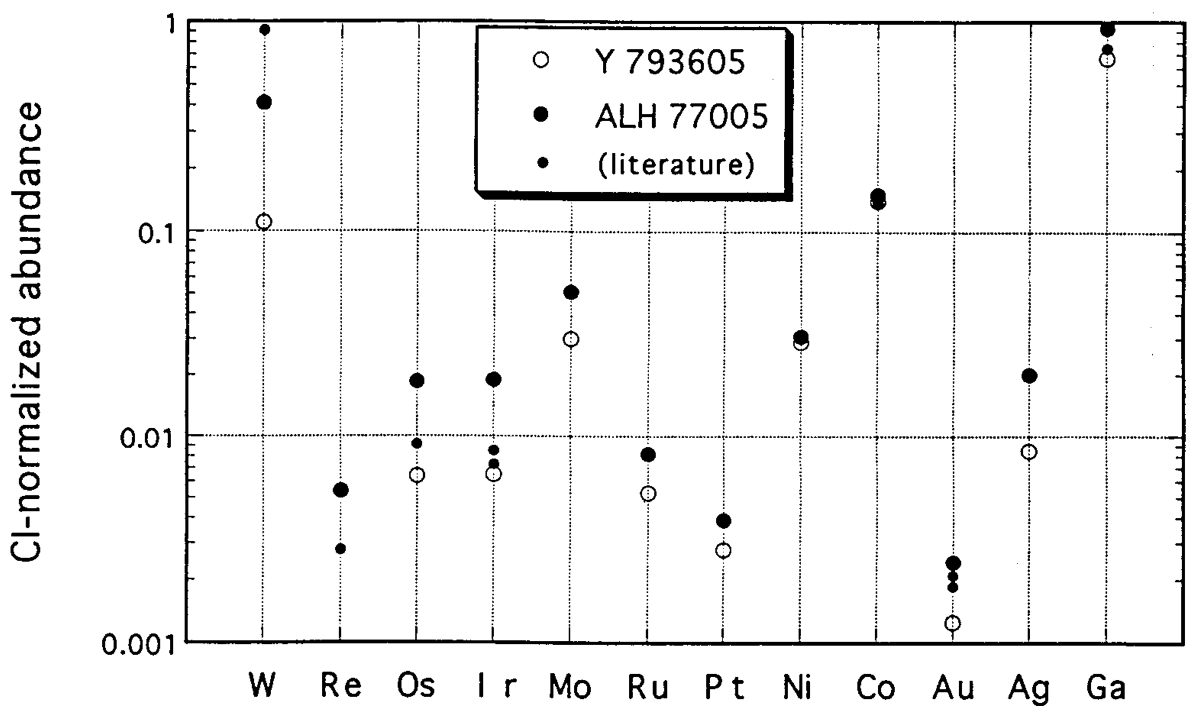

Figure XIII-6. *Chondrite-normalized abundances of siderophile elements in Y793605 determined by RNAA (Ebihara et al., 1997).*

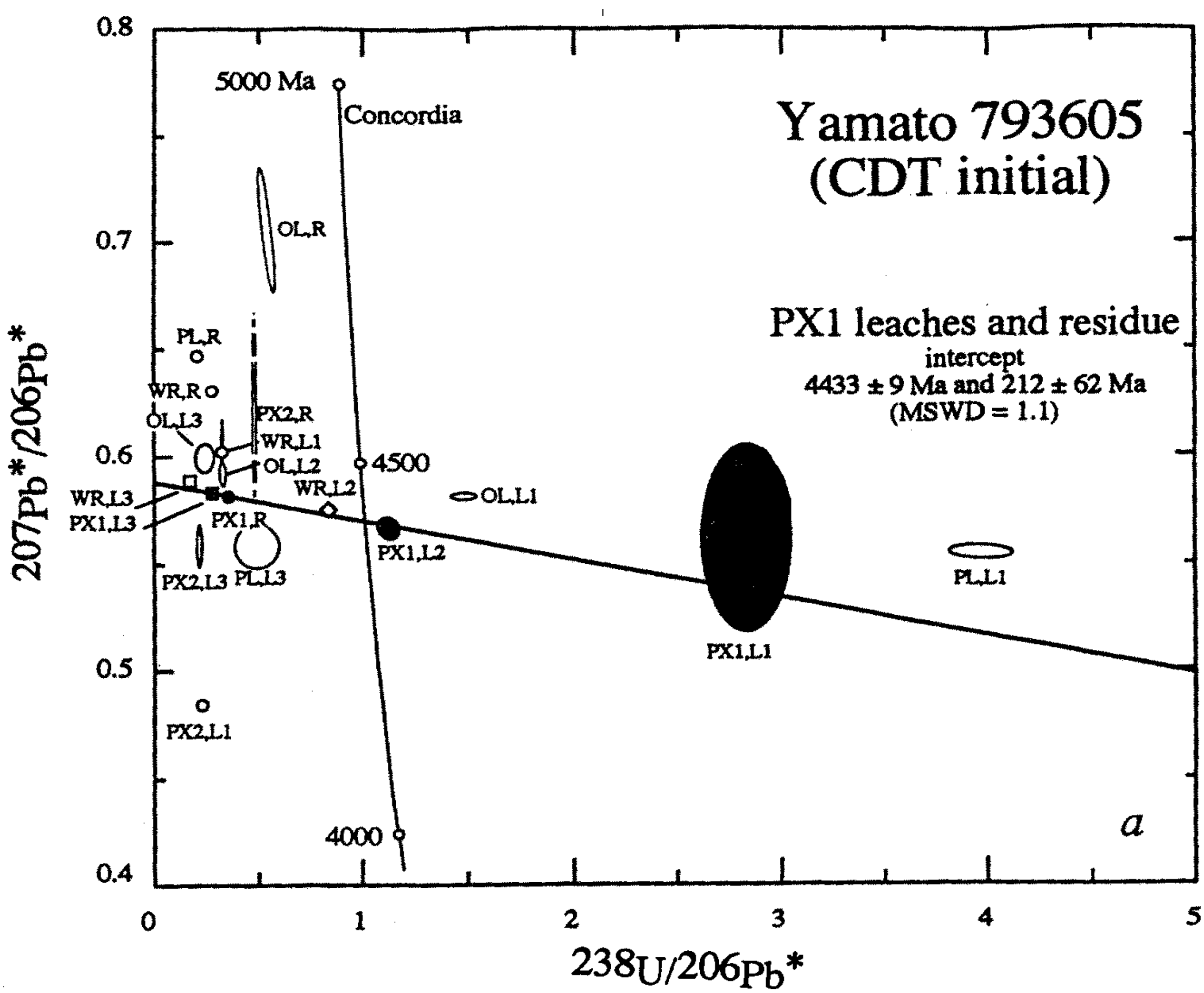

Figure XIII-7. *U/Pb concordia diagram of Misawa et al. (1997).*

lithologies, poikilitic and non-poikilitic. In the poikilitic area (figure XIII-2), large pyroxene oikocrysts enclose rounded olivines (~1 mm) and euhedral chromites (~0.5 mm), and maskelynite is rarely observed. The non-poikilitic area is composed of subequal amounts of olivine, maskelynite and pyroxene.

A large fraction of the sample consists of "*globby enclaves and veins of a dark grey aphanitic or glassy material - presumably formed by shock melting*" (Kojima *et al.*, 1997). These "glassy" regions are actually microcrystalline (Kojima *et al.*, 1997). In hand specimen, Y793605 is also fairly extensively weathered, with a few tiny, elongate white minerals (evaporites?). Many mineral grains show secondary alteration around their rims (Ikeda, 1997). However, the thin sections of this rock do not show much of the weathering or "glass" lithology.

Mineral Chemistry

Yanai (1995) reported mineral compositions for "type D diogenite" including intermediate plagioclase compositions. Mikouchi and Miyamoto (1997) reported detailed mineral compositions and described the zoning in mineral composition.

Maskelynite: The composition of maskelynite is $An_{55}Ab_{44}Or_1$ in the core and $An_{45}Ab_{52}Or_3$ at the rim (Mikouchi and Miyamoto, 1997).

Pyroxene: The host pyroxene in Y793605 is pigeonite (Ikeda, 1997, Mikouchi and Miyamoto, 1997). It is chemically zoned from $En_{76}Fs_{21}Wo_3$ in the center to $En_{66}Fs_{23}Wo_{11}$ at the rim. Pigeonite is often rimmed by augite $En_{52}Fs_{16}Wo_{32}$ (figure XIII-3). The trace element contents of pyroxenes are reported by Mikouchi and Miyamoto (1997) and Wadhwa *et al.*, (1997). There is little or no orthopyroxene.

Table XIII-1. Chemical Composition of Y793605.

reference	Mittlefehldt 97		Warren 97		Ebihara 97
weight			*310 mg*		
SiO2 %			45.43	(b)	*see figures for data* (c)
TiO2			0.35	(b)	
Al2O3			2.32	(b)	
FeO	19.3	(a)	19.68	(b)	
MnO			0.48	(b)	
CaO	2.7	(a)	4.06	(b)	
MgO			26.2	(b)	
Na2O	0.274	(a)	0.35	(b)	
K2O			0.024	(b)	
P2O3					
sum			**98.89**		
Li ppm					
CaO					
FeO					
S					
Cl					
Sc	20.7	(a)	25	(b)	
V			202	(b)	
Cr			6900	(b)	
Co	68.8	(a)	72	(b)	
Ni	326	(a)	280	(b)	
Cu					
Zn	83	(a)	49	(b)	
Ga			6.8	(b)	
Ge					
As					
Se					
Br					
Rb					
Sr					
Y					
Zr					
Nb					
Mo					
Pd ppb					
Ag ppb					
Cd ppb					
In ppb					
Sb ppb					

reference	Mittlefehldt 97		Warren 97		Ebihara 97
Te ppb					
I ppm					
Cs ppm					
Ba					
La	0.201	(a)	0.29	(b)	
Ce					
Pr					
Nd					
Sm	0.298	(a)	0.45	(b)	
Eu	0.13	(a)	0.206	(b)	
Gd					
Tb	0.12	(a)	0.168	(b)	
Dy					
Ho					
Er					
Tm					
Yb	0.4	(a)			
Lu	0.065	(a)	0.08	(b)	
Hf	0.39	(a)	0.51	(b)	
Ta			<0.04	(b)	
W ppb					
Re ppb					
Os ppb					
Ir ppb	6	(a)	3	(b)	
Au ppb			<0.8	(b)	
Tl ppb					
Bi ppb					
Th ppm			<0.06	(b)	
U ppm					
technique	**(a) INNA, (b) INAA, MFBA and RNAA, (c) ICP-MS**				

Chromite: Chromite is found included in olivine and pigeonite and also in contact with maskelynite (Ikeda, 1997). Chromite included in olivine is richest in Al_2O_3. Chromite found in contact with maskelynite is zoned to ulvospinel.

Olivine: The composition of olivine reported Kojima *et al*. (1997) is Fo_{66-69}, similar to that of LEW88516 but less Mg than that of olivine in ALHA77005 (Fo_{72}).

Ilmenite: Minor ilmenite (MgO = 5%) has been reported (Mikouchi and Miyamoto, 1996b).

Phosphates: None found by Wadhwa *et al.* (1997).

Salts: Kojima *et al*. (1997) reported "*a few tiny, elognate grains of bright white materials*".

Magmatic inclusions: Small magmatic inclusions were found in olivine and pigeonite including rhyolitic and "silica-predominate" glass (Ikeda, 1997).

Shock-melted glass: This microcrystalline material was allocated to various investigators for noble gas studies (Kojima *et al.,* 1997).

Whole Rock Composition

Mittlefehldt (1997), Ebihara *et al*. (1997) and Warren and Kallemeyn (1997) reported the chemical composition of Y793605 (Table XIII-1 and figures XIII-4-6). The trace element pattern is similar to that of LEW88516 and ALHA77005.

Radiogenic Isotopes

Misawa *et al*. (1997) reported U, Th and Pb systematics for Y793605 (figure XIII-7). Leached pyroxene seperates gave an apparent isochron with intercepts at 4433+/-9 and 212 +/- 62 Ma. The Pb isotopic composition of Y793605 confirms a low-mu (high initial Pb) source of shergottites *(and shergottitic peridotites)* compared to volcanic rocks on the Earth.

Cosmogenic Isotopes and Exposure ages

Eugster and Polnau (1997) have determined a cosmic exposure age of 4.1 +/- 1.0 Ma. Nishiizumi and Caffee (1997) also reported cosmogenic ^{10}Be, ^{26}Al and ^{36}Cl. They calculated a terrestrial age of 35+/-35 thousand years based on the ^{36}Cl data. This is significantly less than the terrestrial residence age of ALHA77005 (210+/-80 thousand years).

Other Isotopes

Mayeda *et al*. (1995) and Clayton and Mayeda (1996) reported oxygen isotopes for Y793605 (figure I-2). Grady *et al*. (1997) reported the isotopic ratios of C and N as a function of release temperature, up to 1300 deg C. They found that the C and N components were from a mixture of Martian atmospheric *(isotopically heavy)* and magmatic sources *(isotopically light).*

Nagao *et al.* (1997) reported the isotopic composition of noble gases released by step-wise heating of Y793605. Nagao's split was about 80% "*melt lithology*" (Kojima *et al.,* 1997).

Processing

Yamoto 793605 (collected in 1979) was processed and allocated (in 1996) by the National Institute of Polar Research to a consortium led by Drs. Kojima, Miyamoto and Warren. The sample was widely distributed internationally (Kojima *et al.,* 1997). At least 7 thin sections are available, from two different pieces (Kojima *et al.,* 1997). This well-organized consortium study illustrates how much can be learned about another planet from just a small sample (~ 2.1 gram)!